Master's Thesis

The Role of Tactile Interaction in Anxiety as Negative Emotion

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Abstract

In these days, coping with an anxiety as a negative emotion became a daily issue for people. People attempts various methods such as taking medicines, listening to music, or having a massage therapy to handle the negative emotions. According to the literature studies and exploratory study, it was found that touching behaviors have a connection with the anxiety. In the literature studies, touch sense was divided into various properties which help to observe objects. Even though the studies on the various properties of touch sense were carried out, the relationship between touch sense and the anxiety was not studied deeply. In this research, therefore, the research goal was set to provide a knowledge as a reference for designers, such as which tactile interaction is related to the anxiety control. To reach the goal, research question was set as "what role does each tactile experience has in the moment of the anxiety?" Many methods that were used for coping the anxiety forced people to do new activities such as visiting massage place or bringing a phone to listen to music. In this study, we focused on a natural act which can help people to ease the anxiety at the right time, at the right place, and without any new activities. Stimuli utilized for the main experiment were made based on the properties of touch sense referring to literature studies. The experiment was conducted with 50 participants from two different universities, and three different types of business. The video clip provoking anxiety was prepared as a material use for the experiment. Participants touched the stimuli and played while watching the prepared video clip. Participants were asked to rank the stimuli from the most helpful to the least helpful to ease the anxiety, and an interview to ask the reason was followed afterward. From the experiment, we could find out that there are preferred properties of touch sense which is helpful to ease the anxiety. It is expected that this finding will provide a knowledge for future designers to induce them to design products which will have a potential to help users to cope the anxiety.

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I. Introduction

Background

Dictionary generally defines an anxiety as a feeling of nervousness or worry. This feeling of a nervousness became a common issue in these days. Recent studies tell us that students in college are likely experiencing an anxiety six times more than a general population (Evans et al., 2018). As the studies are telling us, anxiety which also called by different names such as tension, stress, worry, and concern is an ongoing issue especially for younger students. At the beginning of the humanity, anxiety, a feeling of a nervousness, was supposed to be a positive feedback for surviving in the wildlife. At the beginning of the mankind, when there was no civilization, human beings intentionally and unintentionally faced a wild beast in everyday life. From this urgent situation, hovering between life and death, a stress is released. This stress brings a change in human body such as increasing pulse rate. This change allows to vitalize physical state of the human beings to be suitable for overcoming the urgent situation. And then, the stress is naturally relieved without causing any additional impacts. In modern days, vitalizing physical state to step out of an urgent situation is not effective anymore because we do not face a savage on the way home or need to face them to fill our hunger. Instead, we deal with our superiors, take exams, and face deadlines which cannot be solved by manipulating physical state. Because the stress cannot be naturally relieved, it comes to us with negative feedback such as anxiety. These days, people try various methods to overcome the stress: mind-body practice such as praying, breath-focus meditation, therapeutic touch (Kemper,2011) and listening to music (Bradt,2013).

When we look through the anxiety-easing-methods, we can see a common feature from them. They all require an extra step to perform the methods. To make it easy to understand, people needed to stop what they were doing and close their eyes to pray, take out their phone and earphones to listen to music, or visit a clinic to get a therapeutic touch when they are at the moment of anxiety. Taking another step to cope the anxiety seemed to be inefficient. Therefore, short interview named exploratory study was conducted to find out what people do at the exact moment of the anxiety. From the study, it could be generalized that people tend to use their hands at the very moment of anxiety. Mostly, people rubbed their hands or fingers, or played around with any objects which were located next to them. It could be also inferred that stimulating touch sense of hand can be efficient to reduce the anxiety, and, also, cutout extra steps.

Human skin has a great ability which can communicate various senses when it perceives a touch from external action (Elena Azanon, 2019). When human receives an external stimulus, sensory nerves and brain transfer a certain information to feel, and subsequently to move our body. Penfield studied the

relationship between sensory nerves and human brain, and found a knowledge that there are particular regions which can highly affect brain. Those particular regions were eyes, noses, mouth, and hands (Schott, G. D., 1993). Figure 1 is an illustration of homunculus which is drawn based on Penfield's experiment (Penfield, 1937). Body parts of homunculus has an abnormal ratio of proportion. The bigger size portion illustrates highly sensitive region of human body. As we can notice from the study of Elena and Penfield, skin is the first gateway to perceive an external stimulus, and hands are the most effective part of skin to feel the external stimulus.

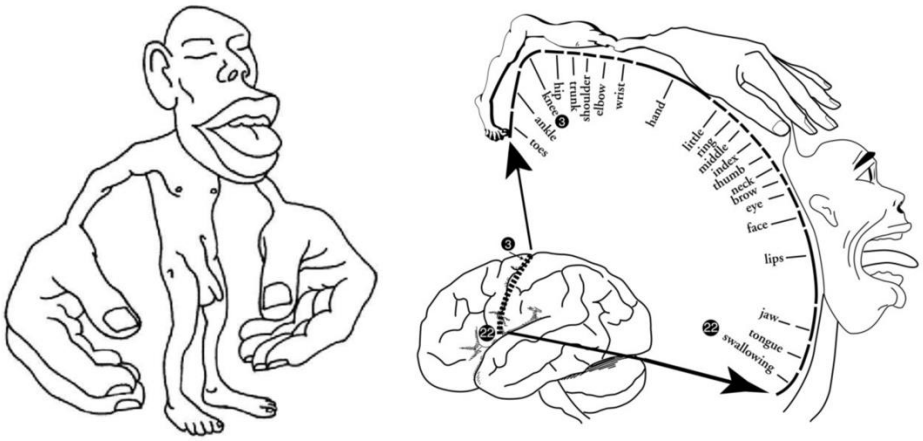

Figure 1. Homunculus illustrated based on Penfield's experiment (Penfield, 1973).

Back to easing the anxiety, tactile touch such as massage is also widely used to reduce stress of patients (Henricson, 2008; Homayouni, 2012). This tactile touch, a physical contact, is very common interaction among people. However, a relationship between touch and negative emotion is not thoroughly studied. In the previous study, it is found that touch can influence in reducing cardiovascular and pain rating (Fishman, 1995); it also tells that stress and pain can be eased by a touch interaction. Fishman investigated the relationship between touch and stress. However, the touch Fishman used was a literal touch of a person's wrist. It was a study of comprehensive touch interaction but, unfortunately, he did not study deeply more specific types of touch interactions.

Numbers of previous studies about touch interactions can be found, but the relationship between a touch and an emotion is little studied. When the touch is broken down into various types of touches, studies are hardly carried out. In the Hertenstein's study, emotions are exchangeable through touch interactions, and these emotions are communicated by various types of touch interactions defined as tactile behaviors (Hertenstein,2006). The study is telling that there are interrelations between emotions and tactile behaviors. Hertenstein, unfortunately, the studied for the interaction between a person and a person, not between a person and products. The study about a touch interaction between a person and products was conducted by Klastzky. However, the founding which is called haptic exploratory procedure (EP) was

utilized for exploring properties of products (Klatzky,1985), but not related to an emotion. Touch is a common interaction between a person and a person, or between a person and products. Though handling a negative emotion such as a stress, anxiety, or depression has gained attention for a long period, unfortunately the studies associated with touch and negative emotion are hardly found.

In this paper, it is tried to investigate how tactile interaction relates to negative emotions. Research goal was set to provide a knowledge as a reference for designers, such as “which tactile interaction is related to the anxiety control.” In order to investigate the relationship between the tactile interaction and the anxiety, research question such as “what role does each tactile experience has in the moment of the anxiety?” was proposed.

II. Theoretical Foundation

Now we know that using hands, a touch, is the highly seen behavior that people try to do when they feel the anxiety. We wanted to know the relationship between a touch and anxiety. To obtain basic knowledge of touch and emotion, literature studies were needed to be conducted. Among the literatures, two basic foundations for this paper were built: tactile behavior, the ways of touches when communicating emotions, and haptic exploratory procedure, the ways of touches when exploring a product.

2.1 Literature Studies

2.1.1 Stress reduced by Tactile Touch

In various contexts such as geriatric care and palliative, tactile touch was utilized as a great interrelating method (Henricson, 2008). The study was conducted to find new and unconventional measures to appease a negative influence of stressors for patients who are in intensive care. 44 patients and five touch therapists participated in this study. Patients were separated in two groups, tactile touch therapy group and normally resting group which is a group with no touch therapy. Interestingly, the result of this study showed that the group of patients who received a tactile touch therapy showed significantly low level of an anxiety value than the patients who took a rest as usual. From this study, we can realize that the touch interaction has some influence on the negative emotion however the tactile touch given from this study was a person to person context with a therapeutic massage.

2.1.2 Physical Interaction from a Product giving a Personality

Nonphysical traits which influences on a human's cognition and behavior in various conditions can be defined as a 'personality' (Ryckman, 2004). This individual personality is made use of to determine what we can expect of something (Carver and Scheier, 1996). Pieter Desmet made a couple of devices to test out whether this personality can be applied to a product and be noticed (Desmet, 2008). Desmet conducted two experiments with a quantitative number of participants. One group processed the experiment with two devices which had same appearance but different interaction. Also, the other group processed the experiment with two different devices but this time the appearance was different. Participants could perceive some personalities such as boring, dominant, honest, easygoing, gentle, lively, and elegant from the devices. From the experiment, the study could draw a conclusion that the designing interactive products with different personalities are possible however appearance as how it looks like has a stronger effect than the interaction style to make the personality from the product. Personality and emotion could be similar but are placed in different branch. People feeling the emotion

is influenced on personality of each people. As the reference from this study, potential is shown that a product can be designed to manipulate the emotion.

2.1.3 Relieving Stress and Pain by Touch

There was a study to find out a potential benefit of incidental touch which usually occurs during a medical treatment in hospital (Fishman, 1995). Heart rate and blood pressure were measured to test out whether the incidental touch is effective to relieve a stress and pain. Heart rate and blood pressure were measured while the stress was not given, stress is given with incidental touch, and only stress is given. Incidental touch was done as experimenter touching right wrist of a subject. Stress was given to the subjects by putting their left hand while glove is worn into an ice water. From the experiment, they could draw a result that the physical contact such as the incidental touch can decrease a cardiovascular and pain value. Rating of the stress and pain increased while the hand of the subjects was in the ice water. However, the rating was comparatively low when the hand of the experimenter was on the wrist of the subject while stress is given to the subject. This study is providing a fact that even a small touch such as the incidental touch can have a potential of relieving the negative emotion such as stress and pain.

2.1.4 Tactile Behavior

There are a couple different types of context in a touch interaction. The most common touch interaction takes place between a person to person. By this touch interaction between a person to person, emotions can be expressed and read by each other (Hertenstein,2006). Various types of emotions such as anger, fear, happiness, sadness, disgust, and surprise were an object to figure out whether they are communicable by the touch interaction. Two participants were sat at a table and a black curtain was crossing between the participants to separate them and make them not able to see each other. One participant was asked to express a certain emotion by touching a bare arm of the participant who is sitting at the opposite side of the black curtain. From this procedure, various types of touch interactions were investigated: typical touching types were patting, hitting, squeezing, trembling, shaking, swinging, lifting, stroking, pushing, tapping, finger interlocking and rubbing (figure 2). These types of touch interaction were defined as tactile behaviors (Hertenstein,2006). The study is telling that the touch interaction is not about just a touch, it covers diverse touch types which are now called tactile behaviors. Unfortunately, the lack of this study is that it investigated the relationship between emotion and touch of person to person.

Figure 2. Tactile Behavior: type of touch interactions (images from Google).

2.1.5 Haptic Exploratory Procedure

Another context in a touch interaction is an interaction between person to product. Typically, when a person gets to see a new object, they tend to explore and identify it (Gibson,1962; Schifferstein et al.,2005). A study was done about how people identify and explore an object. The study found out that people have a certain procedure when they explore an object: the procedure is defined as the haptic exploratory procedure which is short as EP (Klatzky,1985). According to the haptic exploratory procedure, EP, there are seven typical movements to explore an object; lateral motion, pressure, static contact, unsupported holding, enclosure, contour following, and part motion (figure 3). 'Lateral motion EP' is done to explore the surface of an object by rubbing the exterior or interior of an object with its fingers and to obtain a knowledge of a texture of an object. 'Pressure EP' is conducted by putting a force or torque to an object with its fingers or hands; it is done to obtain a knowledge of hardness of an object. When a person holds an object, a heat from the contacting surface of the object is transmitted to the person's hand. This behavior is called 'static contact EP' which is done to obtain a knowledge of temperature. When lifting, hefting, and wielding is done to explore an object, 'unsupported holding EP' is involved; it is associated to obtain a knowledge of weight of an exploring object. 'Enclosure EP' is seen when an object is molded by a person's hands or fingers; enclosure EP enables to explore or identify the global shape and volume of an object. When people what to explore an exact shape of an object, 'contour following EP' is used. Finger or hand contact is keep maintained while following the surface of an object. Finger or hand is smoothly move along the edge of an object to obtain the knowledge of exact shape of it. 'Part motion EP' is literally a part motion procedure; it is done to explore a part of an object however this EP is only done when a moving part is existing (Klatzky,1985).

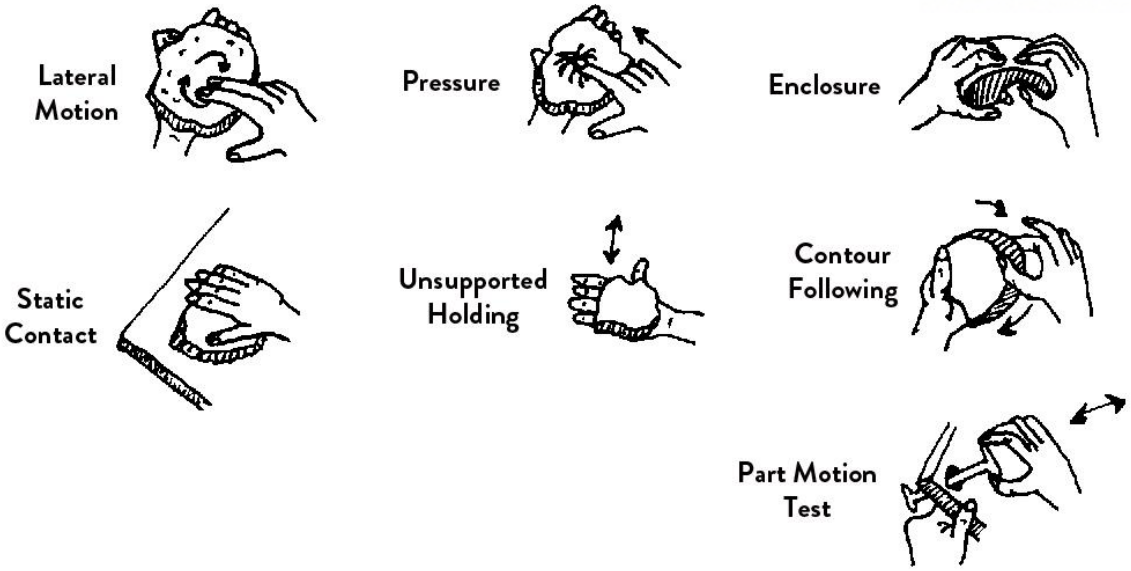

Figure 3. Haptic Exploratory Procedure: Seven movements (Klatzky, 1985).

2.2 Direction of the Research

According to the previous literature studies, correlation between emotion and touch sense has been solidly found. However, previous studies practically used the 'touch' as a general touch interaction. Touch interactions from the studies were basically putting a hand on top of something or performing an act such as a massage or exploring an object. The studies did find out that these touch interactions have a potential to communicate the emotion however communicating was occurred between person to person. Person to object interaction was studied to figure out which properties of touch sense are used to explore an object however it did not study how those properties can be related with the emotion. Based on the previous founding from the studies such as touch and emotion do have a correlation, this research is intended to find out not just correlation between touch and emotion but move little further deeper to figure out how this touch can make a difference in the negative emotion state such as the anxiety.

III. Exploratory Study

From the previous studies, we could see that people try to do a new behavior when they feel the anxiety. To make it easy to understand, when people start to feel the anxiety, they stop doing whatever they were doing and try to move out from the situation and find something to ease it. People try to avoid the anxiety moment and do a new activity such as praying or meditation. They walk out the situation and bring their earphone and start to listen to a music. Some goes to a massage shop to relax and cope the fully anxious mind and body. Definitely these coping methods are effective however there is a couple of limitations. We do not know when the anxiety moment comes, and the anxiety could overcome when we cannot avoid the situation such as presentation or project meeting. Based on these facts, we questioned "without conducting a new behavior, is there a way that people can ease the anxiety with a natural act?" For the further study, an exploratory study was conducted to find out the natural act that people do when they feel the anxiety.

To find out the natural act that people do when they start to get anxious, an interview as method was conducted. 30 participants were recruited from Ulsan National Institute of Science and Technology. 17 were male students and 13 were female students. Their age ranged from 23 and 29 years old and the average age was 27.3. The interview took approximately 15 minutes and it was held at wherever the participants felt comfortable. Interview questions were basically formulated to find out when they feel anxiety, and what action do they take at the anxiety moment. The questions were, "In which situations do you feel the anxiety?" and "What do you usually do when you feel the anxiety?"

Figure 4 is the bar graph which shows when the participants usually felt the anxiety in their daily life. We can notice that there are a variety of causes that provoke the anxiety from this graph. However, there are a couple of noticeable marks we can pay a close attention. In our life, a situation of explaining something to a third person comes unexpectedly frequently. Dealing with one or two persons cannot be a problem. However, participants mostly felt the anxiety when they need to stand in front of numbers of people to talk. Comfortable feeling follows when people already have an experience at something which means they are 'familiar' at it. When people face an unfamiliar circumstance such as moving to a strange place or meeting a strange person, it triggers to bring up the anxiety. This facing strange place or person was second highest mentioned reason by participants that makes the anxiety. Also, there are numbers of reasons that participants start to get anxiety such as coming up due date of project or submission, talking with superior, facing an unexpected situation, having a business meeting, trying a new experience, unprepared for something, and more.

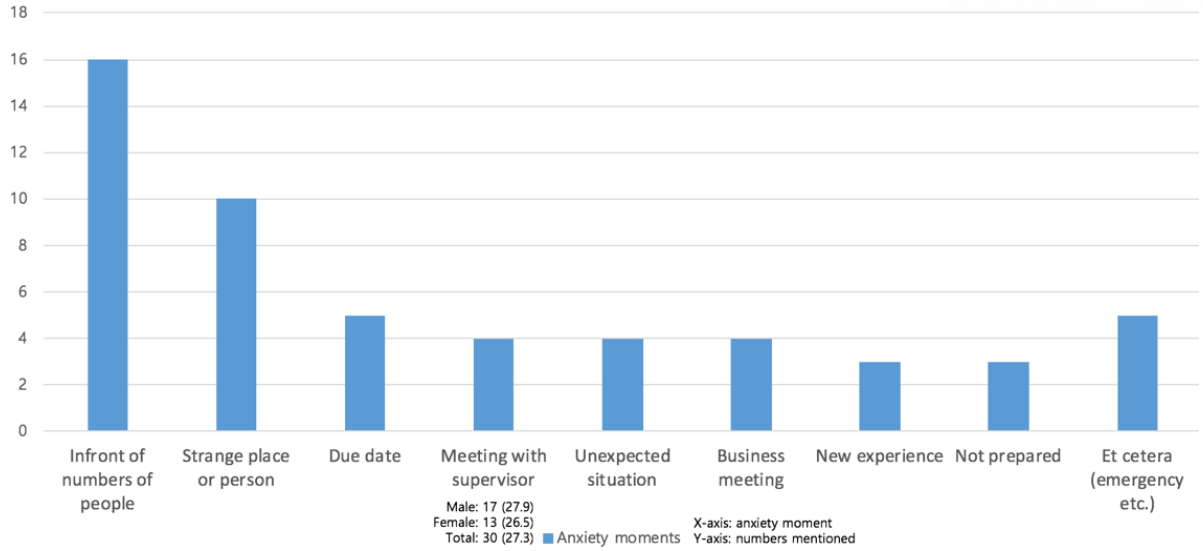

Figure 4. Anxiety moments.

Figure 5 shows a gender difference about when people usually feel the anxiety in their daily life. Interestingly, cause of the anxiety between both genders did not show a significant difference. Dominant factors that provoked anxiety were same as both genders. Both genders mostly experienced the anxiety when they need to stand in front of numbers of people and when they encounter a strange place or a strange person.

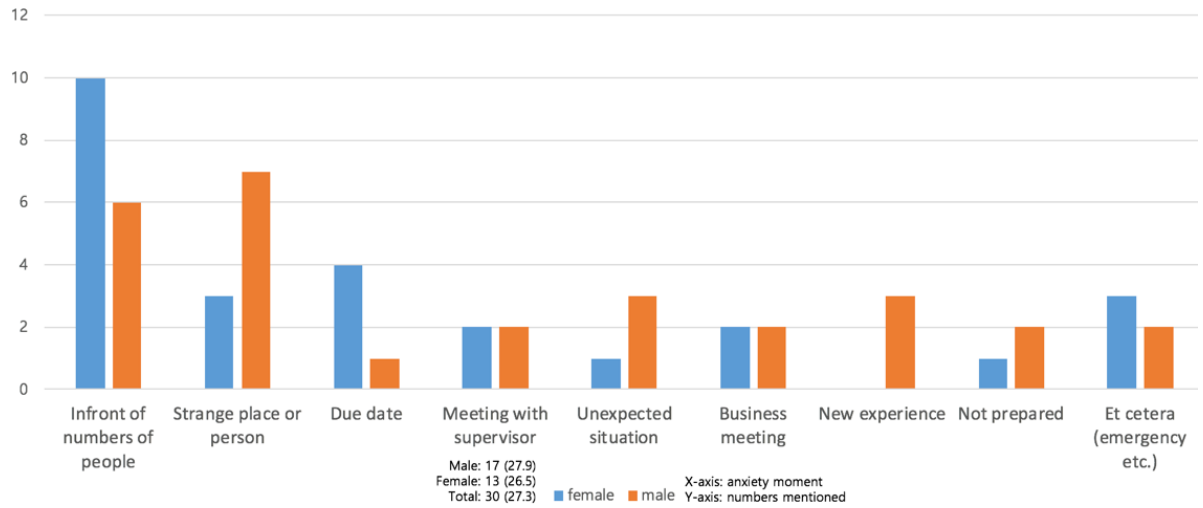

Figure 5. Gender difference of Anxiety moments.

Then, we wanted to know what people do when they face the anxiety moment. What is the natural behavior that people do when anxiety moment comes? Figure 6 is the bar graph that showing what people do during the anxiety moment. As we can see from Figure 6, rubbing its fingers or hands marked the highest number that participants do during the anxiety moment. Touching a tangible object followed

right behind and marked second place. Followed up was tapping something with its finger, scratching, clearing mind, doing nothing, breath controlling, drinking water, chewing fingernails, and so on. From this bar graph, we can clearly see that participants tend to use their hands when they feel the anxiety.

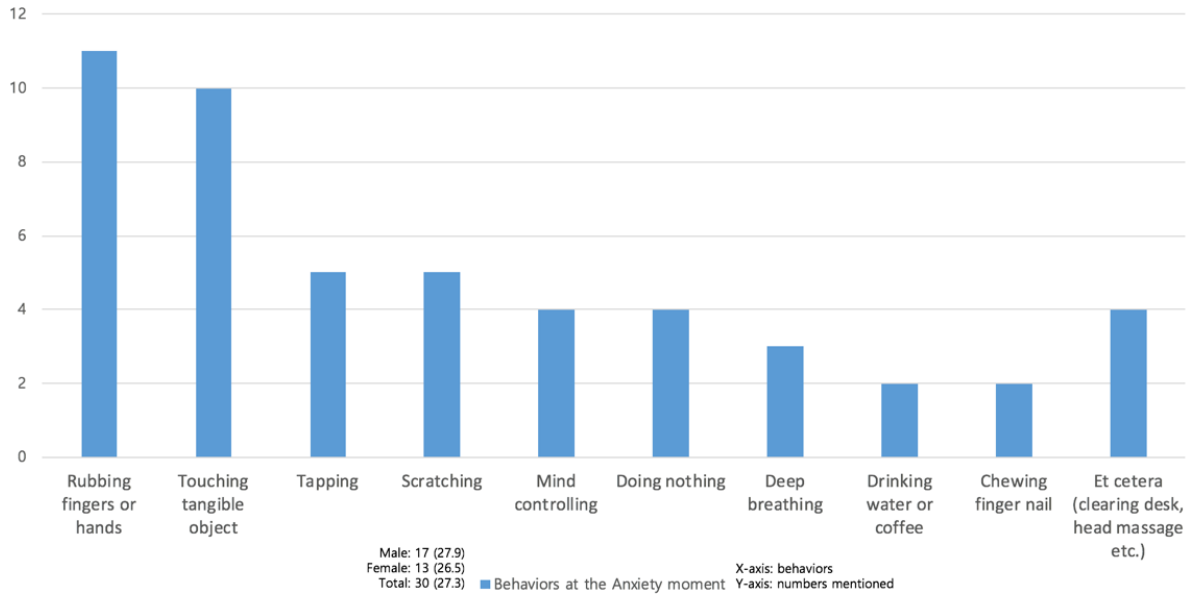

Figure 6. Behaviors at the Anxiety moment.

Figure 7 shows the gender difference about the behaviors of the participants during the anxiety moment. From the graph we can notice a couple of difference from both genders. Rubbing fingers or hands and touching a tangible object were both highest number that were mentioned from both genders however male participants tended to touch a tangible object more than female participants. Significant difference was appeared after those two reasons. A physical act such as tapping or scratching were mentioned much more from male participants. Meanwhile, mentally rest such as trying to do a mind controlling was mentioned more from female participants. Male participants showed more tendency to act a physical behavior such as doing nothing, drinking water, chewing fingernail, and more. Overall, participants in both genders highly tend to use their hands at the anxiety moment. From this study, we could find that using hands is the natural behavior that people tend to do when they face the anxiety. Also, we could find that there are a little of difference between genders such as male participants tend to do more physical act when they feel the anxiety, but female participants tend more mentally way to cope the anxiety. Based on this exploratory study and literature study, considering the natural behavior during the anxiety is using hands and defined knowledge of touch sense having a variety of difference, experiment was planned to discover deeper findings of relationship between hand touch sense properties and the negative emotion in case of the anxiety.

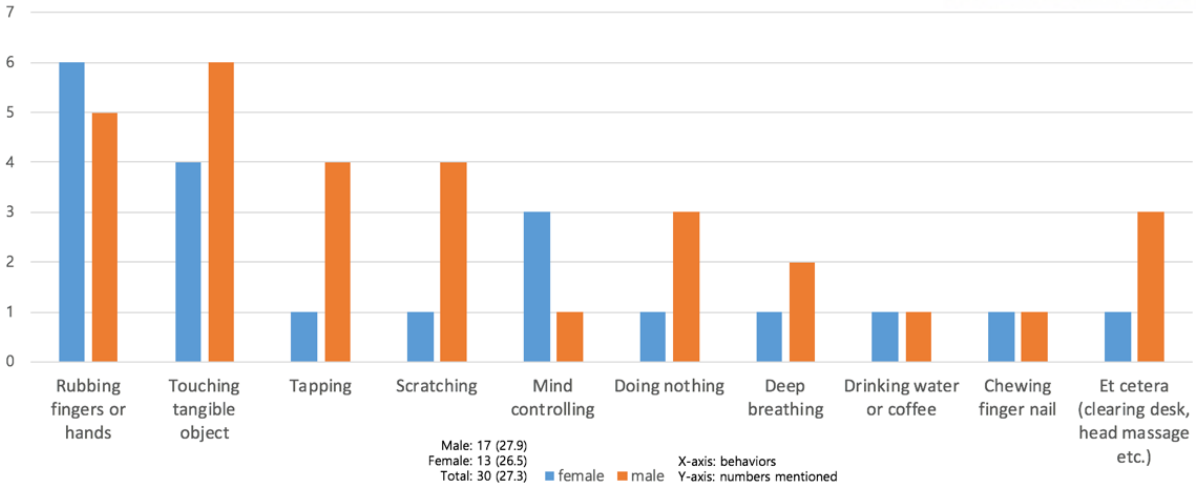

Figure 7. Gender difference of Behaviors at the Anxiety moment.

IV. Research Method

From the exploratory study, we gathered the information that hand touch is the main behavior that people tend to do when they feel the anxiety. Literature study built a foundation that touch is important and contains a high potential to communicate the emotion between person and a product. From these studies, unfortunately, we could see only the potential but not direct relationship between touch and negative emotion, anxiety. So, we planned to conduct experiment stimuli to find and prove the relationship between hand touch and anxiety. Eight stimuli were made based on literatures. They were designed and made just to test out to find whether touch sense and anxiety have a relationship and, if so, how each touch sense property responses to the anxiety emotion.

4.1 Experimental Stimuli

4.1.1 Selecting variables

Tactile behavior and Haptic exploratory procedure (EP) are the two main touch interaction that were defined by researchers. They contain solid knowledge about touch interaction that people act during interaction between person to person or person to product. Therefore, we wanted to utilize their knowledge to make the stimuli for the experiment. First, common features were found between Tactile behavior and Haptic exploratory procedure. Table 1 is showing the common features of the two knowledge.

Table 1. Common features between Tactile behavior and EP

Lateral Motion (texture)	Pressure (hardness)	Static Contact (temperature)	Unsupported holding (weight)	Enclosure (volume)	Contour Following (global shape)	Part Motion (part motion)
Patting	Hitting		Shaking	Shaking		
Rubbing	Squeezing		Swinging			
	Tapping		Lifting			
	Pushing					

Patting and Rubbing behavior in Tactile behavior matched well with lateral motion in Haptic exploratory procedure. Lateral motion is defined as exploring a texture which is well experienced by patting or rubbing of an object. Hitting, squeezing, tapping, and pushing acts in Tactile behavior were well matched with pressure which defined to explore a hardness of an object in Haptic exploratory procedure. Shaking, swinging, and lifting motion in Tactile behavior matched well with unsupported holding trait in Haptic exploratory procedure. Unsupported holding is defined to explore a weight of an object which is best to feel by shaking, swinging, or lifting. Shaking behavior in Tactile behavior could

be included in enclosure trait in Haptic exploratory procedure. Enclosure is defined to feel a volume of an object. Volume can be well detected by just holding an object which is close to an act of shaking. When the table was set, static contact, contour following, and part motion were eliminated. There were no common features between two knowledge. Lateral motion which explores the property of texture, pressure exploring the property of hardness, unsupported holding exploring the property of weight, and enclosure that explores the property of volume were condensed. Table was utilized to find which properties were used mostly during the anxiety moment. Table and the bar graph from the exploratory study were compared (figure 8).

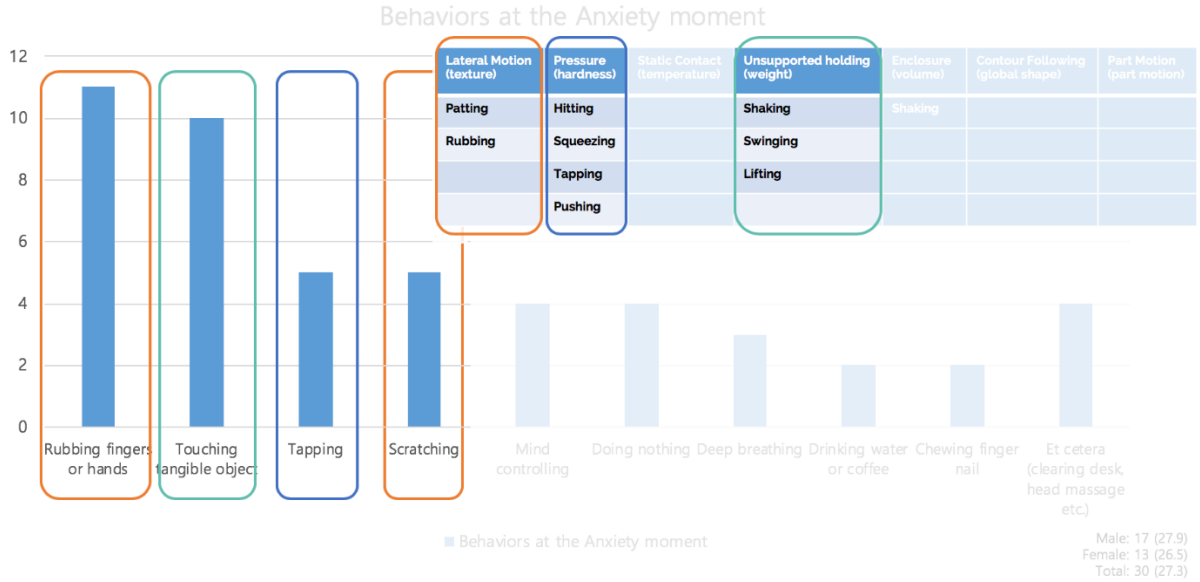

Figure 8. Comparison between table 1 and figure 1.

Rubbing fingers or hands matched with the lateral motion which goes with the behavior of patting and rubbing. Also, scratching behavior came under the lateral motion since the scratching motion can easily be done to feel the texture. Touching a tangible object matched well with the unsupported holding which contains the behavior of shaking, swinging, and lifting. Tapping an object matched well with pressure which goes with the behavior of hitting, tapping, squeezing, and pushing. Enclosure which is explores a volume property was eliminated because there was no good matching with any behaviors that people try during the anxiety moment. So, three properties such as texture, hardness, and weight were utilized to build the stimuli for the experiment.

4.1.2 Prototyping

The experiment conducted to find out whether touch sense and anxiety have a relationship and, if so, how each touch sense property responses to the anxiety emotion. Therefore, each property (texture,

hardness, and weight) was divided into two different levels. Difference level was set as an extreme opposite scale because this research aimed to figure out what property is effective to response to the anxiety but not to find out how much of weight or hardness level was best to control the anxiety. To provide two different level of texture feelings, fur fabric for smooth and soft texture and hemp cloth for rough texture were used. Hardness level was divided into two different levels by using a silicon with hardness level 7 for soft and tender feeling and hardness level 24 covering 3D printed sphere for hard and solid feeling. For the weight difference, four of 22.5g weights, total 90g, were put inside the stimuli for the heavy weight feeling. Total weight for the heavy weight level was 170g±10g which includes the weight of 3D printed sphere frame, silicon, fabric, and iron weights. Total weight for the light weight level was 60g±10g which includes the weight of 3D printed sphere frame, silicon, and fabric. The numbers of the weight were set to provide an extreme difference between heavy and light weight feeling. Figure 9 shows the process of making the stimuli for the smooth texture, hard hardness, and heavy weight stimulus (left) and smooth texture, soft hardness, and light weight stimulus (right).

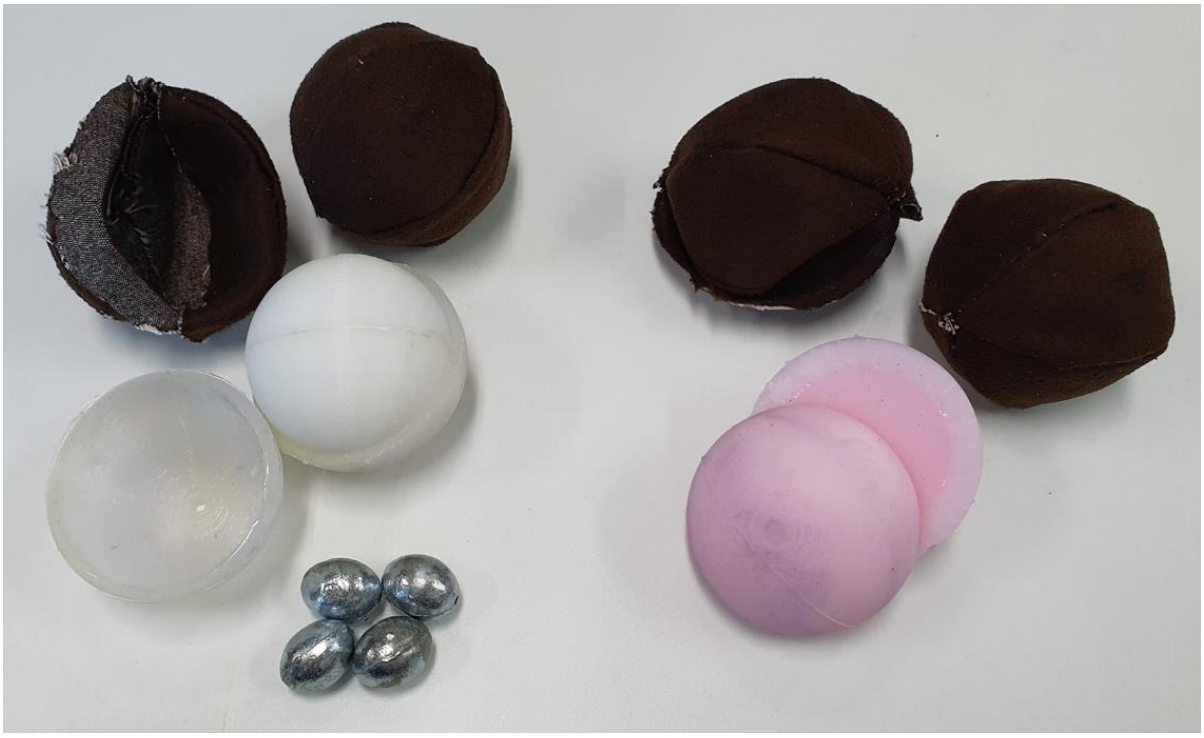

Figure 9. Middle of process making stimuli.

With three properties, texture, hardness, and weight, and total six levels of the properties, smooth, rough, soft, hard, light, and heavy were combined to make total of eight stimuli (figure 10).

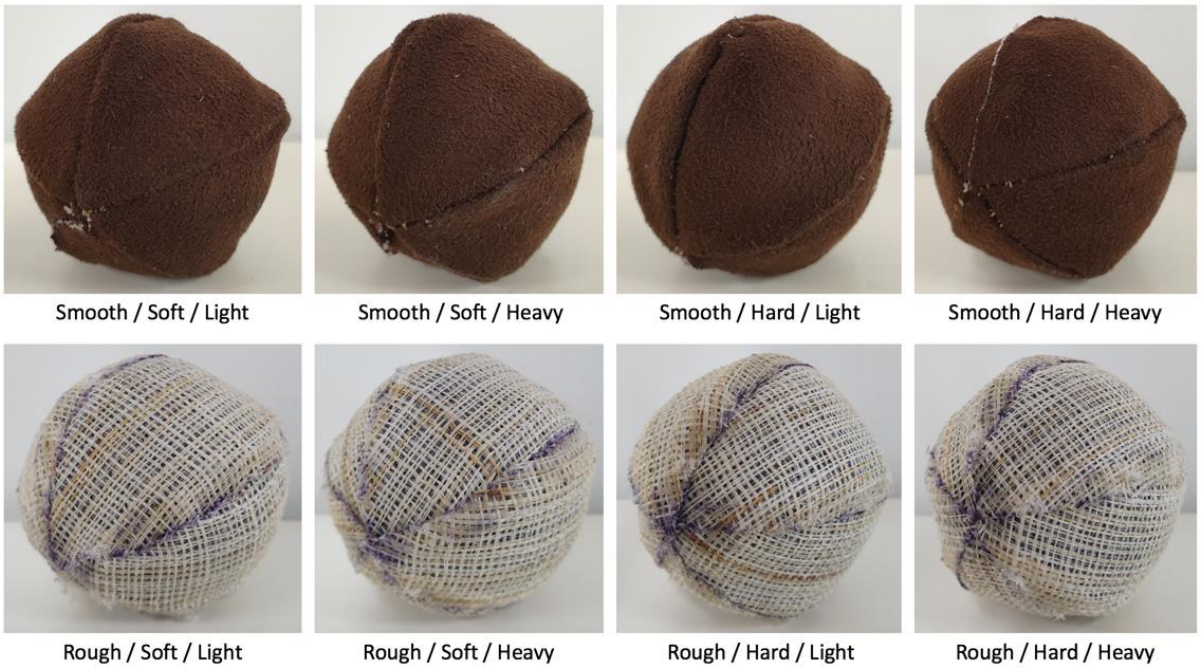

Figure 10. Eight different stimuli.

4.2 User study

4.2.1 Material

For the main experiment, we needed something that can provoke the anxiety. We prepared three video clips which were recommended by movie manias from movie website. Mission Impossible (1996, close call scene), Assassination (2015, train scene), and Twister (1996, tornado scene) were the three video clips (figure 11). To select the most anxiety provoking video clip, we recruited 15 participants to watch them and select one. Participants were recruited at Ulsan National Institute of Science and Technology. They came to room 1004 and watched the three video clips and then ranked the clips by most anxiety provoking order (figure 12).

Figure 11. Three video clips.

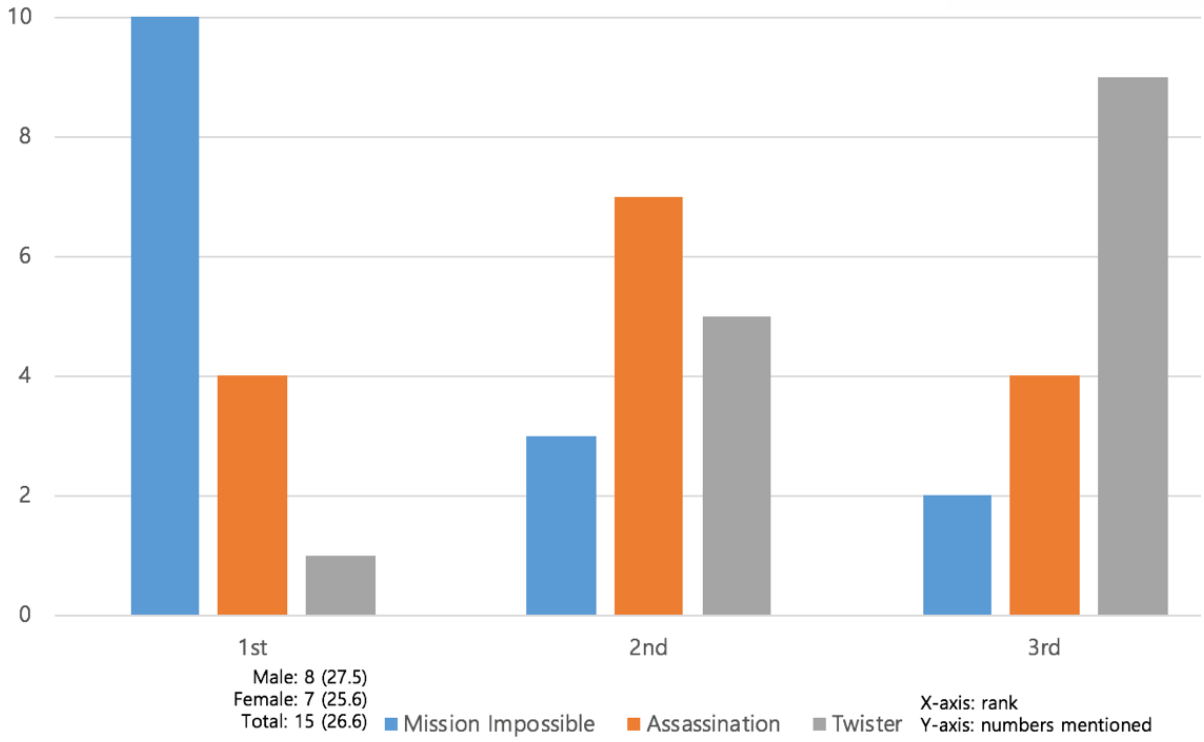

Figure 12. Rank of the anxiety provoking video clips.

Overwhelmingly, Mission Impossible, close call scene, were selected as the most anxiety provoking video clip. Digital version of Mission Impossible was purchased and edited. To test out the effectiveness of the selected video clip with the eight stimuli, pilot test was conducted. 3 participants were recruited from Ulsan National Institute of Science and Technology. Selected video clip was shown to the participants and they played round with the stimuli at the same time. Stimuli well stimulated human touch sense however the video clip shown to provoke the anxiety did not work well enough. Because the clip was a part of a movie film which was made for an entertainment, whether the participants watched the movie or not made a big difference of being immersed in the anxiety situation. To make a better experiment setting, video clip to provoke the anxiety needed to be changed. To find a new clip, analyzed bar graph from exploratory study which shows when people feel the anxiety during their daily life was utilized. Situation such as standing in front of numbers of people to present or talk was the most mentioned circumstance that makes people anxiety. Unfortunately, experiment condition was not sufficient enough to make the situation such as presenting or talking in front of many people. As figure 13 shows, two conditions were used to find a better video clip for causing the anxiety. To make it practicable, a clip that can give a circumstance of facing a strange place or person and unexpected situation was searched. Movie called ‘US (2019)’ was found as the well fitted movie with the conditions such as facing a strange place or person and unexpected situation. Genre of the movie is mystery and thriller however only a part of introduction was use for the experiment. Edited video clip does not

contain any scenes of violence or frightening but only shows an atmosphere of strange place and unexpected situation with a strange sound effect (figure 14). Video clip was tested out whether it is provoking anxiety to three participants in Ulsan National Institute of Science and Technology. Test was set as participants to watch the two different video clips and choose which one is better to make the anxiety. Then asked to answer whether is it effective to make the anxiety or not. All three participants selected the edited video clip of 'US (2019)' and commented that it was effective enough to make the anxiety feeling while watching the clip.

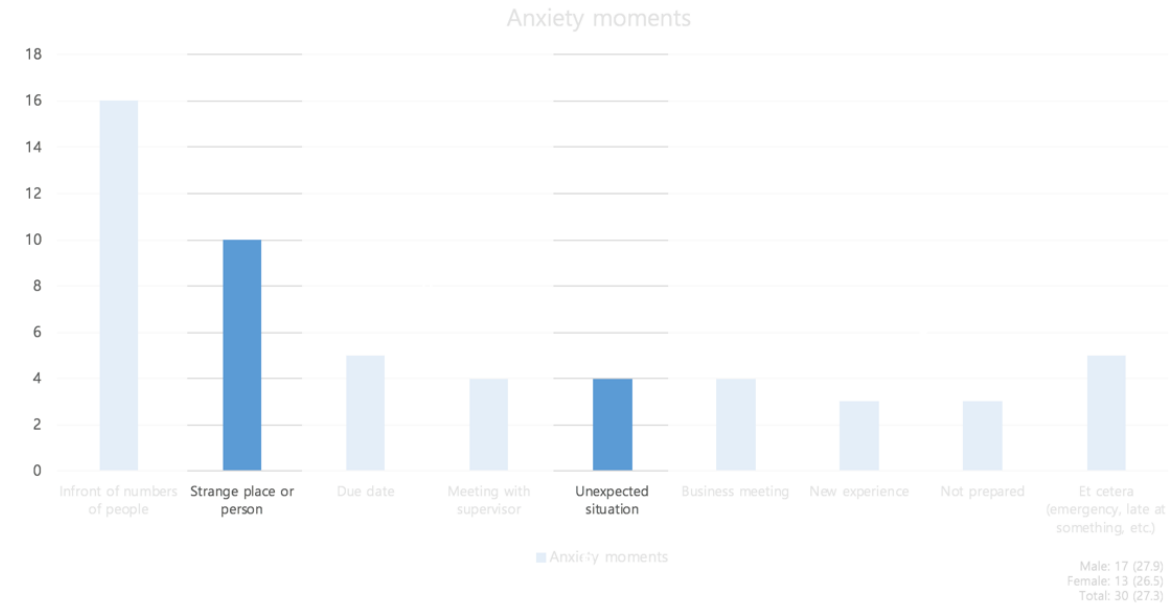

Figure 13. Anxiety moments for finding anxiety provoking video clip.

Figure 14. Part of the anxiety provoking video clip.

4.2.2 Participants

For the main experiment, 50 participants were recruited. 20 participants were recruited from Ulsan National Institute of Science and Technology and 30 participants were recruited from Gyeongsang National University. Age of the participants was ranged from 21 through 43 years old and the average age was 27.5. Average experiment time was 25 minutes and it was hold at 'homelab' which is located at room 1004 in Ulsan National Institute of Science and Technology and room number 108 in Gyeongsang National University.

4.2.3 Procedure

Participants was asked to explore the eight stimuli about one minute. While they were exploring the stimuli, brief explanation about the experiment was guided to them. When participants were set to start the experiment, light was turned off to enhance the anxiety and video clip was played. While participants watching the video clip, they were asked to play around with the eight stimuli to find out which stimulus were helpful to ease the anxiety or not (figure 15). Video clip was edited to be played about four minutes. They were noticed that they can stop the video clip whenever the video clip makes the anxiety overwhelming. When the clip was over, short interview was conducted. For the interview, three main questions were asked:

- Please rank the stimuli by most helpful stimulus to ease the anxiety to least helpful
- What factors helped and not helped to ease the anxiety?

When the participants make a rank, they were able to make a tied rank with multiple stimuli. For the future use, photo of the listed stimuli by helpful to not helpful were taken. To get comments for each properties, texture, hardness, and weight, direct questions such as 'you have not mentioned about hardness property, did it not influenced you to make this decision?'

Figure 15. Participating the experiment.

4.3 Data analysis

To collect the data from the experiment, affinity diagram was conducted. During the interview, voice of the participants was recorded, and key phrase or sentences was typed by a personal laptop at the place. After the experiment was done, phrases were reorganized with utilizing the recorded voice. Reorganized phrases were cut as a sentence and the affinity diagram method was used for grouping phrases which implies the same meaning (figure 16). Phrases in the group was counted, and each group was noted with a number which meant the number of mentioned by the participants. Afterward, the phrases were divided by genders which allowed to collect the data of gender difference.

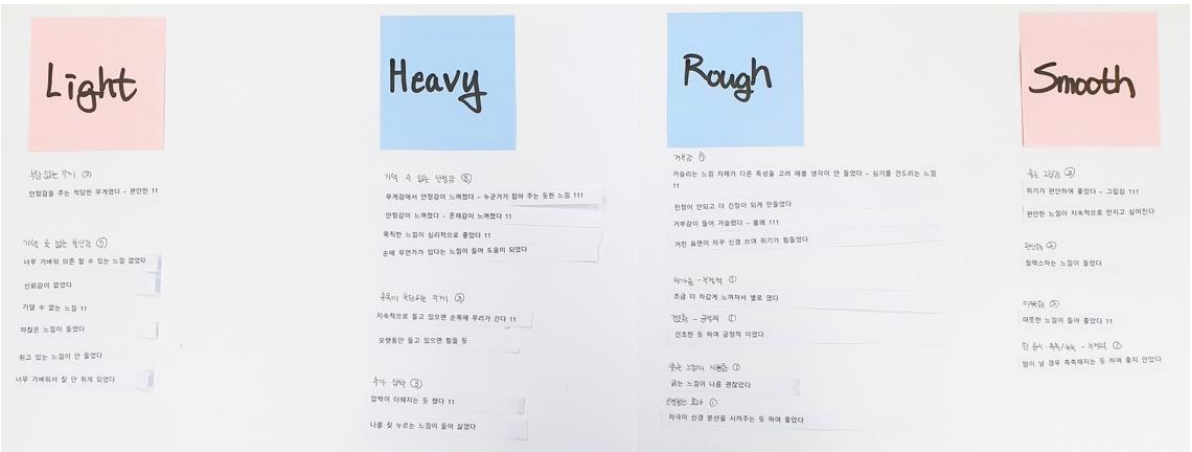

Figure 16. Utilizing affinity diagram.

V. Results

As the objective of this research, inevitably, it had to collect data as subjective responses from the participants. Experimenting 50 participants allowed to collect a quantitative data. As the collected data is large enough, the responses appeared to be generalized. Affinity diagram method was used to make an analysis. Analyzed data was visually made as a bar graph. To find more insights and make the result more generalizable, gender difference was implemented. Since there were three properties such as texture, hardness, and weight and these three properties were divided into two levels which made total of six levels of properties, comments for each levels of properties were analyzed. Also, comments about the combination of the properties were analyzed.

5.1 Stimuli Preference

The first task that the participants were asked to do after watch the anxiety provoking video clip was to list up the stimuli by most helpful stimulus to ease the anxiety to least helpful stimulus to ease the anxiety. Figure 17 shows the preference of the stimuli to use when the anxiety comes out for both genders. During the step of make an order of the rank, large number of participants only considered first place to fourth place but did not considered after fifth place. This phenomenon can be analyzed as that first to fourth place ranked stimuli were regarded as giving a positive feedback, but the leftover stimuli were regarded as giving a negative feedback. Some participants only gave placing for two to three stimuli and disregarded the leftover stimuli. This result made a significant number focused at the lowest ranks such as seventh and eighth place. Reason for this phenomenon will be talked more in detail at '5.2 Property Preference' section.

From the bar graph, remarkable numerical value is detected. Four stimuli, combinations of 'smooth texture, soft hardness, and light weight' and 'smooth texture, soft hardness, and heavy weight' and 'rough texture, hard hardness, and heavy weight' and 'rough texture, hard hardness, and light weight' made a significant mark. Combinations of 'smooth texture, hard hardness, and heavy weight' and 'smooth texture, hard hardness, and light weight' and 'rough texture, soft hardness, and heavy weight' and 'rough texture, soft hardness, and light weight' were comparatively distributed evenly for overall. 'Smooth texture with soft hardness and light weight' and 'smooth texture with soft hardness and heavy weight' overwhelming received positive feedback. They were hardly seen under fifth place. Meanwhile, 'rough texture with hard hardness and heavy weight' and 'rough texture with hard hardness and light weight' stimuli overwhelmingly received negative feedback. They were hardly seen over fifth place. This phenomenon was seen also in the gender difference (figure 18, figure 19).

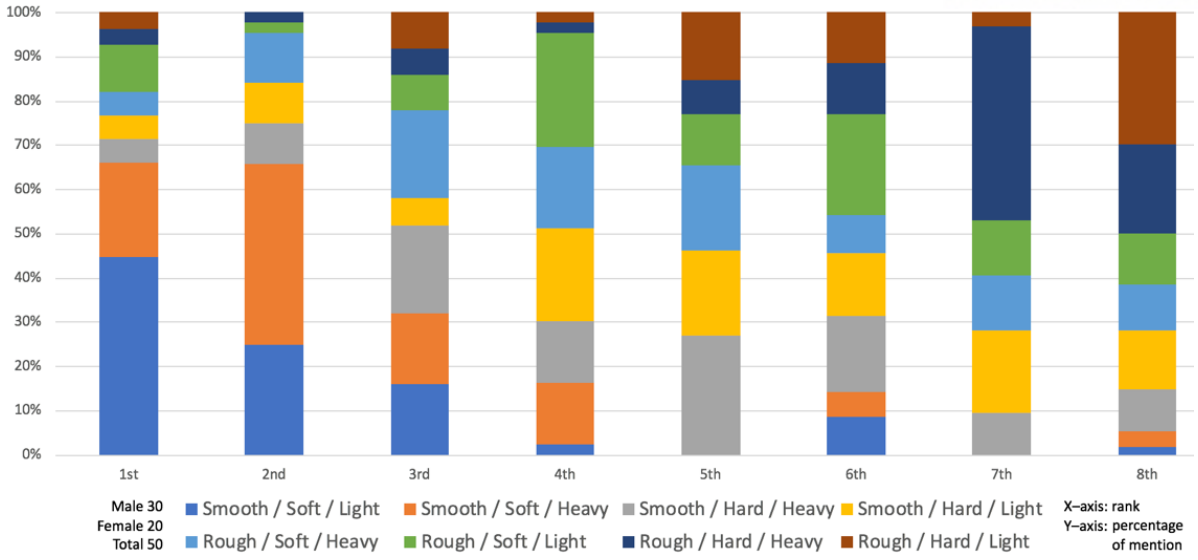

Figure 17. Overall stimuli preference.

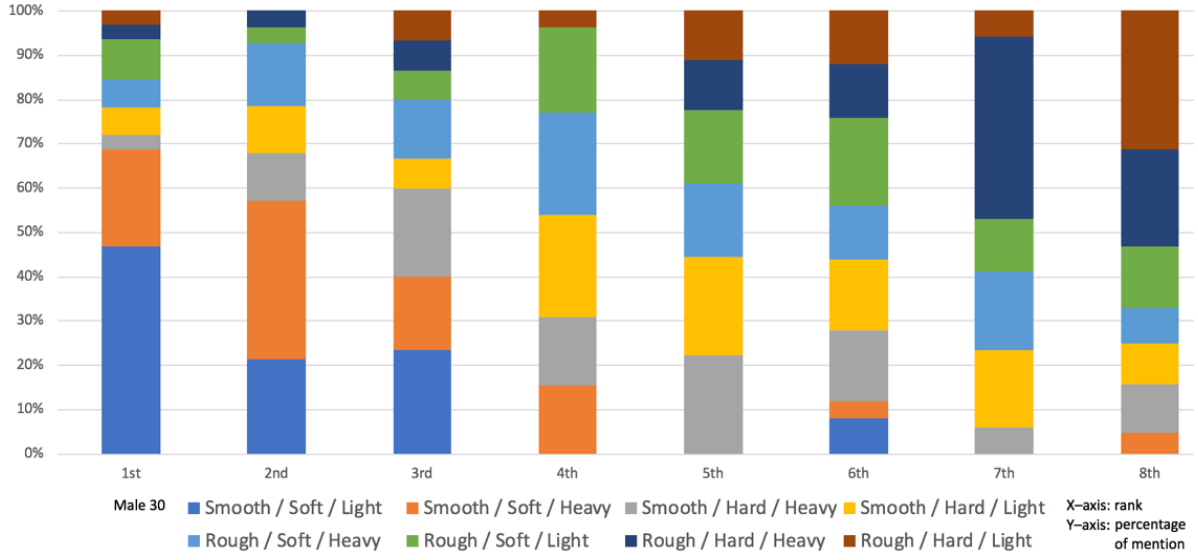

Figure 18. Stimuli preference of Male participants,

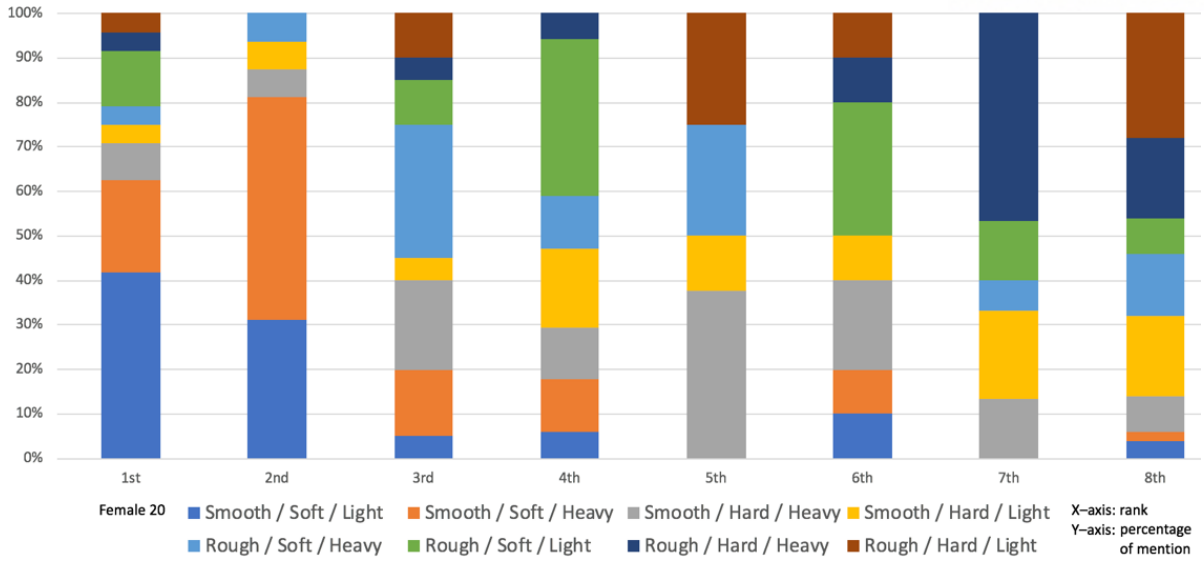

Figure 19. Stimuli preference of Female participants.

Distribution of the stimuli from male participants made a similar graph with the overall stimuli preference graph. Difference that can be found from gender difference graph is that female participants (figure 19) comparatively gave 'rough texture with soft hardness and heavy weight' and 'rough texture with soft hardness and light weight' stimuli a positive feedback. Also, smooth texture and soft hardness combinations were comparatively received positive feedback from female participants (figure 19).

5.2 Property Preference

Stimuli preference graph provides which combinations of the properties are generally preferred to people. By analyzing interviews of participants, reasons for each property receiving positive or negative feedback were observed. Overall rough texture had a significant number of negative feedbacks and smooth texture received positive feedbacks. In hardness property, soft hardness received great number of positive feedbacks and hard hardness received negative feedbacks mostly. In weight property, light weight comparatively received negative feedback and heavy weight comparatively received even number of positive and negative feedback.

5.2.1 Texture property

Main reason for giving a negative feedback for rough texture is that it created high repulsion when it got touched but, nonetheless, it had a little number of positive feedbacks such as dispersing nerve and giving a positive stimulation (figure 20). Since texture is the very first input of hand touch, repulsion of the rough texture made large number participants not willing to consider other properties. This was the main reason for 'rough texture with hard hardness and heavy weight' and 'rough texture with hard

hardness and light weight' stimuli receiving low placing. On the other hand, smooth texture received mostly positive feedbacks contrastively. Figure 21 shows the gender difference on feedbacks about the individual texture property.

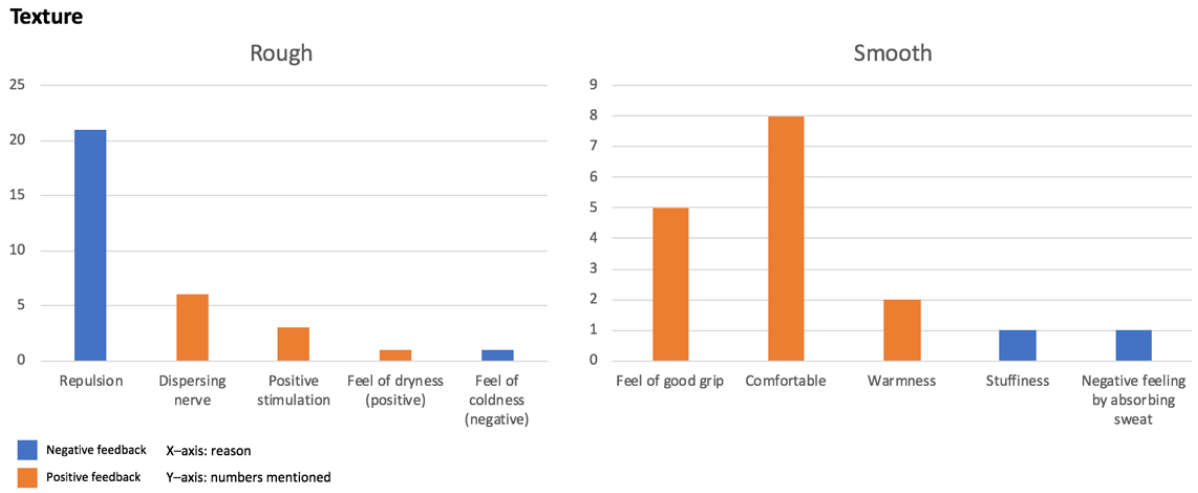

Figure 20. Overall reasons for texture property preference.

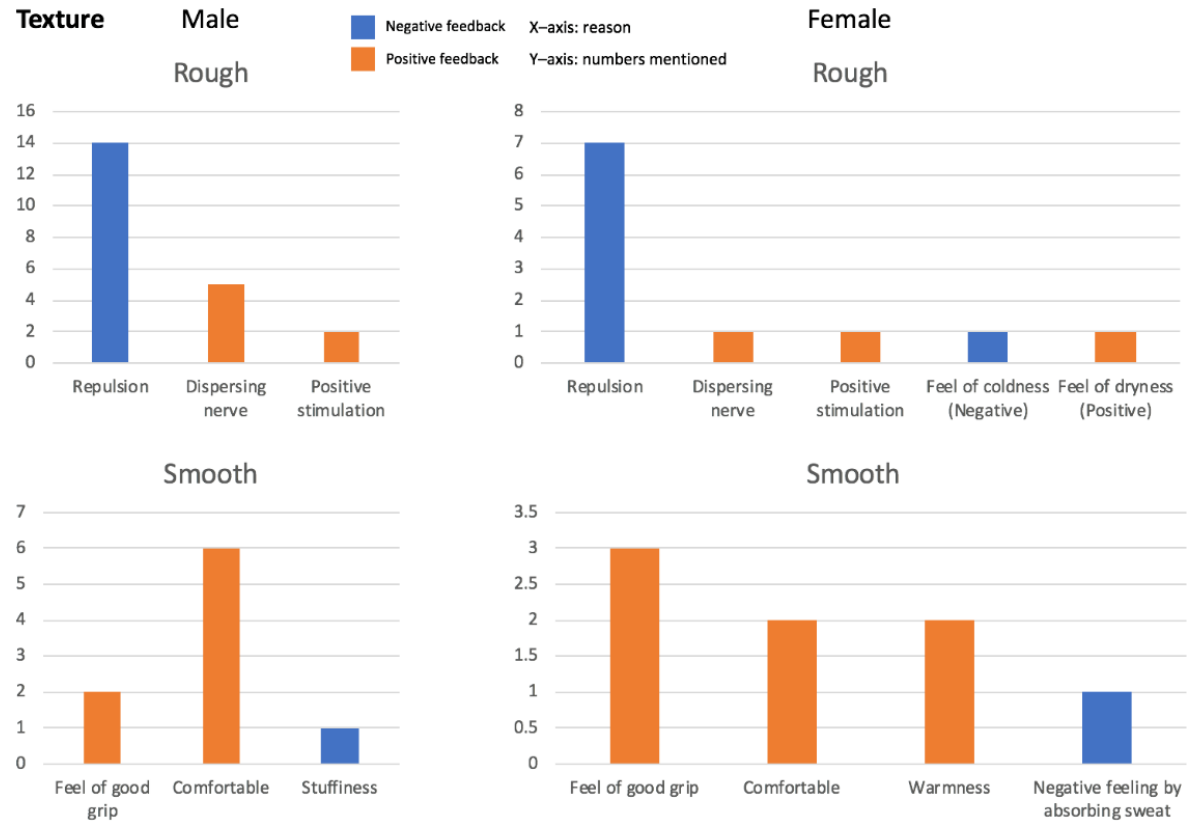

Figure 21. Reasons for texture property preference in gender difference.

5.2.2 Hardness property

Preference for the hardness is very clearly observed (figure 22). Soft level of hardness was commented very positively because of its unique characteristic, a tenderness. Tenderness provided a sense of tension which allowed to change the form of the stimuli as the pressure from the participants. Squeezing was one of the behaviors that participants done mostly while playing around with the stimuli. This squeezing act is optimized to feel the tension with whole part of palm. Whenever participants squeezed the soft hardness stimuli, they could feel the shape changing with their palm and that made them to feel a controllableness. Participants felt that they cannot control their mental when anxiety starts to overwhelm their mind thus feeling the controllableness from the stimuli strongly helped them to ease the anxiety. This applied to both genders. When the pressure is given to the stimuli by their hand, the tension allowed to be squashed in and this made them to feel that the force given to squash is canceled out. It helped participants to feel no pressure. Some female participants mentioned that squeezing the stimuli with a soft hardness is felt like squeezing the negative emotion such as anxiety (figure 23). The meaning of this comment may seem similar with the feeling of controllableness however the difference is that this feeling is to make the negative emotion fade away by squeezing. Meanwhile, hard level of hardness stimuli had mainly negative feedbacks. Strong feeling of stiffness made a repulsion which even made participants do not want to consider the other properties. Because the hard shell does not have any tension, it gave participants to feel their pressure of their hand directly. Additionally, this made participants to feel an extra pressure or force to their hand which did not helped to ease the anxiety at all. Also, having no tension made the stimuli not able to change their form when the pressure is given. This characteristic created a negative feeling mostly to the participants however there was one positive comment about ‘not able to change the form of the stimuli by pressure’. The reason for the positive comment was it could feel stability from the stimuli.

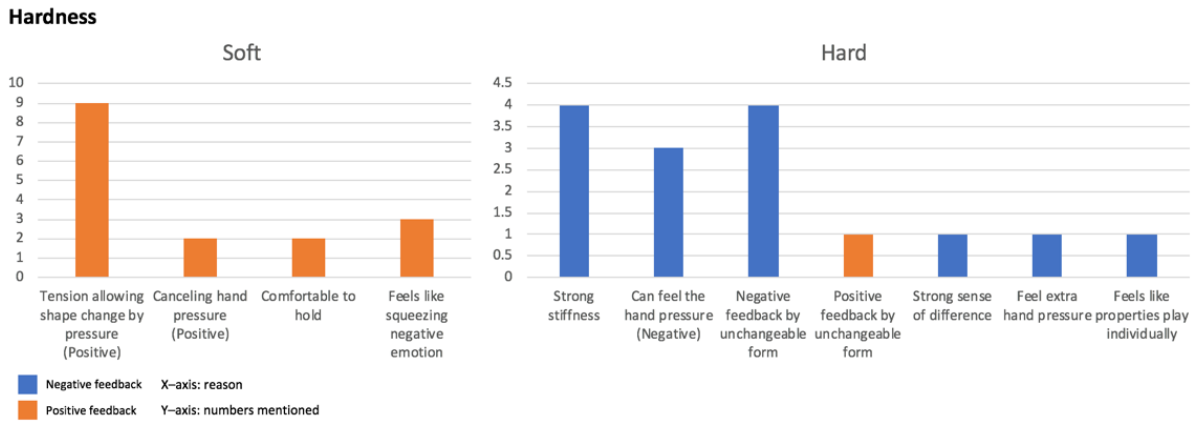

Figure 22. Overall reasons for hardness property preference.

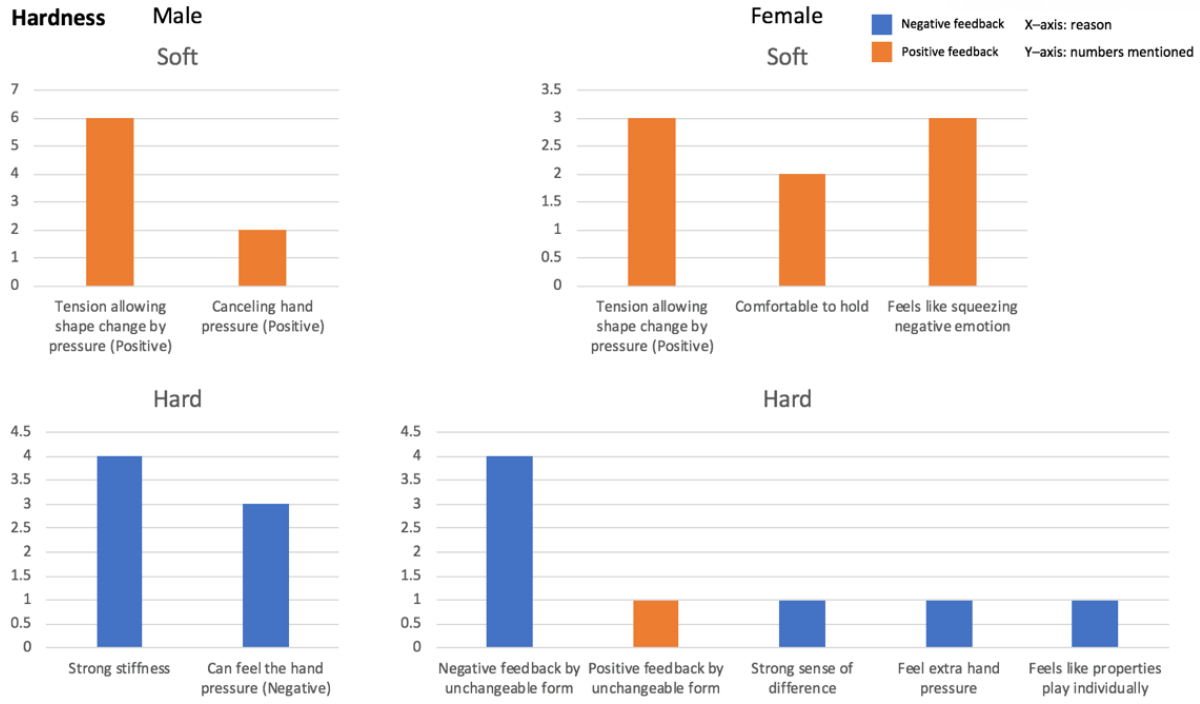

Figure 23. Reasons for hardness property preference in gender difference.

5.2.3 Weight property

Weight property received comparatively even comments in positive and negative feedback (figure 24). Emotions coming from the weight property was same from both genders. Light level of weight property had high number of negative comments because it gave an undependable feeling which created a fear that there is nothing to get a support from. Meanwhile, even it had low numbers of comments, from both male and female, light weight was felt comfortable to hold on and play around with it (figure 25). For the feedbacks from heavy level of weight property, the number of comments in positive and negative feedback were close to even. From both gender, heavy weight made participants to feel like they are holding on a very stable object. Another key point from this comment was ‘feeling of someone is standing next to me’. The heavy weight provided a feeling of dependable which means that the heavy weight stimuli made the participants to feel like someone who is dependable is standing next to them to help to ease the anxiety. Even there were numbers of positive feedbacks, the weight was too heavy that strained the wrist of the participants which made a negative feeling. Also, they felt like the heavy weight transformed to a negative emotion such as stress or anxiety and gave more negative pressure to the holders.

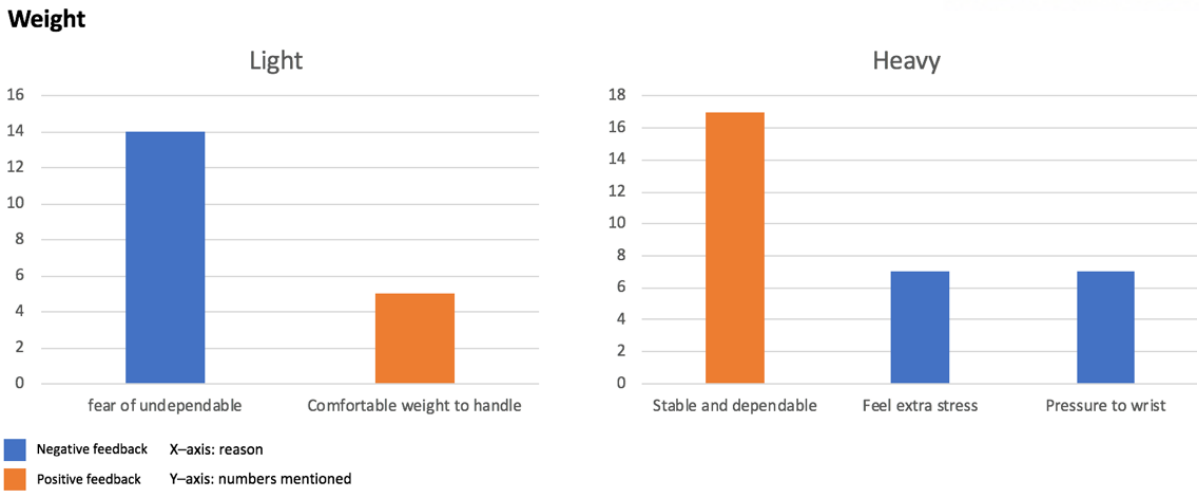

Figure 24. Overall reasons for weight property preference.

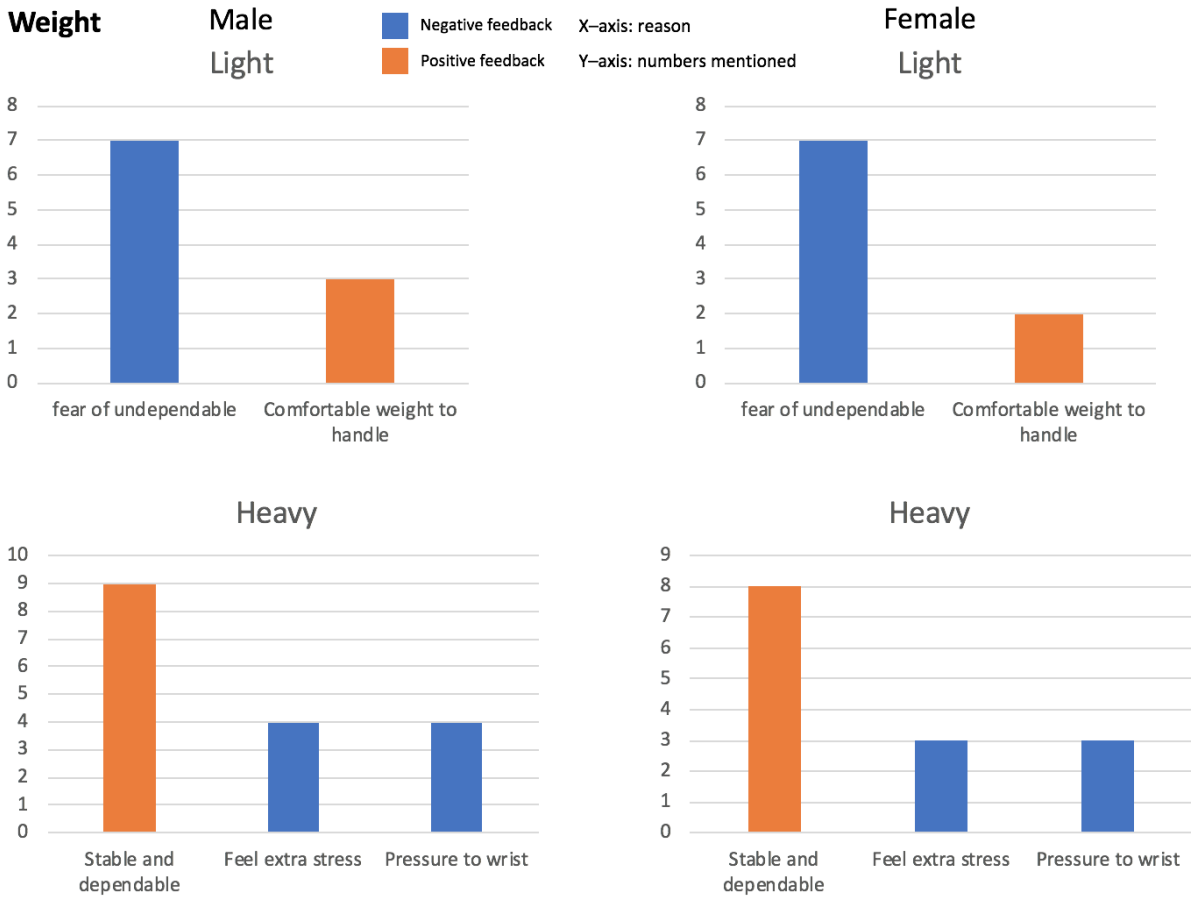

Figure 25. Reasons for weight property preference in gender difference.

5.2.4 Combination of properties

Individual properties itself have strong influence on the users in the case of the touch interaction is

given. When the two or more properties are combined together, each property could make a synergy effect, or one property could dominate other properties. When soft hardness and rough texture is combined, majority of male participants commented that positive feedback of the soft hardness dominated other properties (table 2). They felt a negative feeling from rough texture however the soft hardness overwhelmed other properties and canceled out the negative feedbacks from rough texture and weight property. Meanwhile, majority of female participants expressed negative feeling for the combination of soft hardness and rough texture (table 2). They commented that negative feeling of rough texture dominated other properties thus overall feedback was negative even the soft hardness provided a positive feeling. When rough texture and hard hardness were combined, both genders expressed same comments (table 2). Hard level of hardness had no tension which enhanced the participant to feel the roughness of the texture easier. Negative feeling was doubled up and it led to a negative feedback. Soft hardness and smooth texture were the case of making a synergy effect. Both genders commented that the combination of soft hardness and smooth texture made familiar feeling such as human skin (table 2). This human skin feeling made participants to imagine a gesture of holding a hand which helped them to feel a comfort to calm their mental. The combination also gave a confident that participant itself have a control of its emotion.

Table 2. Preferred reasons following the properties combinations I.

Soft + Rough		Rough + Hard		Soft + Smooth	
Male	Female	Male	Female	Male	Female
Positive feedback of **soft tension dominated** negative feedback of uncomfortable rough texture	**Negative** feedback of **uncomfortable rough texture dominated** positive feedback of soft tension	**Hard frame** made easy to feel rough texture which **increased uncomfortable feeling**	**Hard frame** made easy to feel rough texture which **increased uncomfortable feeling**	**Familiar feeling** such as touching a **human skin** which gave a **positive** feedback	**Familiar feeling** such as touching a **human skin** which gave a **positive** feedback
				Felt it **can control itself**	

Combination of heavy weight and smooth texture received some comments from male participants that the negative feedback of the heavy weight such as feeling pressure to their wrist or feeling an extra stress dominated the positive feedback of the smooth texture (table 3). Meanwhile, female participants commented that the combination helped to imagine someone is holding their hand. When they felt someone is next to them, they felt more comfort and safe. Light weight and rough texture combination doubled up the negative feeling to the participants in both genders (table 3). Unstable feeling of light weight and strong repulsion of rough texture caused synergy effect, in opposite meaning, to each other and made negative feeling in overall. However only from female participants, they mentioned that the rough texture made them to feel like something is on their hand which overwhelmed other properties such as negative feeling of light weight. They said holding on an object helps them to stabilize their mental and rough texture made them to think like it. Combination of light weight with soft hardness and smooth texture received positive comments from both gender (table 3). Male participants said that

combination of those properties made them to feel like anxiety is relieved by squeezing the stimuli. Female participants mentioned that it felt like there are touching a familiar object such as pillow and it enhanced a comfort feeling. When they could feel a familiarity, it greatly helped to ease the anxiety.

Table 3. Preferred reasons following the properties combinations II.

Heavy + Smooth		Light + Rough		Light + Soft + Smooth	
Male	Female	Male	Female	Male	Female
Negative feedback of **heavy weight dominated** positive feedback of smooth texture	Felt like **holding someone's hand**	**Uncomfortable feeling doubled** up by combining unstable feeling of light weight and rough texture	**Uncomfortable feeling doubled** up by combining unstable feeling of light weight and rough texture	Felt like **relieving the anxiety** by **squeezing**	Felt like **touching a pillow** which **enhanced comfortable** feeling
			Felt like **something is on its hand** because of a **rough texture** which **canceled** out a **negative feeling** of light weight		**Familiar feeling enhanced comfortable** feeling

From the female participants only, heaviness of the stimuli made them to think the softness of the stimuli more rigid when the heavy weight and soft hardness were combined (table 4). Soft hardness received a positive feedback when it was combined with light weight from them however the softness turned out more rigid by combining with heavy weight which made the stimuli to receive a negative feedback in overall. On the other hand, same combination produced some positive feedback such as 'it felt like holding a hand of friend or someone to depend'. Combination of light weight and hard hardness had some negative comments that gave a feeling of emptiness which seemed meaningless to hold on to it (table 4).

Table 4. Preferred reasons following the properties combinations III.

Heavy + Soft	Light + Hard
Female	Female
Heaviness made the **soft frame** feel **more rigid**	Felt like **emptiness** which made **meaningless**
Felt like **holding someone's hand**	

5.3 Tactile behavior

Usage of the tactile behavior was observed by the experimenter. Among the behaviors such as squeezing, shaking, lifting, pushing, tapping, padding hitting, rubbing, and more which were defined by Hertenstein, squeezing and rubbing were mostly observed behavior from the participants during the experiment. Lifting motion was rarely seen from the participants while interacting with the stimuli. These behaviors were observed by all participants in both genders thus the numbers were not counted.

VI. Discussion

In this section, we want to discuss deeper about the result based on the experiment. Not just discussing what was seen from the graph but trying to find out some more inspirational insights from the overall experiment and interview of participants. Also, the section will try to find a design implication for future use of this research. At the end of the discussion section, limitation from this research and how this research can it be improved for the further study will be discussed.

6.1 The importance of touch experience by hands in anxiety

According to the result of exploratory study, we could find out that people do various behaviors during the anxiety moment. Some does mind controlling to calm their mind by deep breathing or closing their eyes or doing literally nothing. Drinking water or coffee was also one of the behaviors done they participants. Among these behaviors, using hands was mostly done during the anxiety moment. Participants tended to rub their hands or fingers or touch at an object which is located right next to them. Tapping or scratching an object or their body was another behavior highly seen from the participants. From this study, we could analyze that using hands is highly preferred behavior during the anxiety consciously or unconsciously. They made use of hands to feel something is on their hands or a feel a certain feeling of an object which someway helped them to ease the anxiety: 'I tend to rub my fingers when I feel the anxiety and it helps me to calm down because, I think, it is soft and warm', 'I feel the anxiety when I have a meeting with my supervisor. During the meeting I cannot let my hand free so I tend to keep touch my laptop.' From the graph, the numbers of mentioned show that the touch experience is highly done, and it is, consciously or unconsciously, an inherent behavior in a life of human to control the negative emotion such as the anxiety.

6.2 Tactile properties and gender difference in alleviating anxiety

From the bar graph of the stimuli preference, we can instinctively notice which stimuli have a greater or less preference for people to ease the anxiety. The combination of soft hardness and smooth texture are preferred highly to be used when the anxiety is provoking. Smooth level of texture property itself received highly positive comments from the participants in both genders. However, it did not dominate over other properties when it was combined. Smooth texture had best synergy effect when it was combined with soft level of hardness property. From the stimuli preference (Figure 14), 'smooth texture

with soft hardness and light weight' and 'smooth texture with soft hardness and heavy weight' combinations can be majorly seen from first place to fourth place which can be considered as an upper rank. It can be seen at the sixth place and eighth place. However, the maximum number of picks is only four and this could result from personal differences in taste.

Participants in both genders mentioned that the combination made them to imagine that someone is holding their hand. Feel of someone is standing next to them was the most important factors to ease the anxiety. Especially from female participants, having someone who is familiar and dependable such as family, friend or their lover next to them during the anxiety moments was great factor to ease the anxiety. This feeling was mentioned as a comment for a positive feedback of top tier stimuli by majority of female participants regardless of combination. Therefore, from this analysis, we can generalize that combining the soft hardness and smooth texture can maximize the positive effect and be favored to general people.

Meanwhile, when the rough level of texture property is combined with other properties, it generally received low preference. The graph of preference from male participants seem comparatively distributed equally. But when we look close to the graph, certain number of picks of combinations of 'rough texture with soft hardness' are seen from all over the ranks. This phenomenon can be explained by the effect of soft level of hardness property. For most of the participants, soft hardness provided positive feedback, and this positive feedback had strong influence which could dominate over other properties. However, 'rough texture and hard hardness' combination can mainly be seen at seventh place and eighth place. Majority of participants commented about rough texture and hard hardness negatively, and these two properties were combined which made synergy effect in the negative way. Interestingly, comparatively male were a little insensitive than female that middle rank of the male preferences is evenly distributed but it is clearly separated in female preference graph. From the female graph, feedbacks were comparatively focused at the eighth rank. Highly mentioned feedback from the female participants were such as 'repulsion of the rough texture made me not to consider the other properties' or 'hardness of the stimulus did not provide any dependency which made me not to think about other properties.' It can be discussed that the female participants were more sensitive at the properties thus the dominance of the negative feeling of property was seen noticeably. Nonetheless, most preferred and least preferred are significantly noticeable from the graphs. Texture is the outermost property which is sensed at the very first order. From this research, rough texture can hardly give a positive feeling which means roughness of the surface of a product need to be considered in more careful when it needs a direct touch.

Individual light and heavy level of the weight property had clear reasons for the pros and cons, figure 21, however noticeable dominance between two levels of the weight property cannot be seen from the

stimuli preference graph, figure 16. It can be noticed that two levels of the weight property were comparatively distributed evenly among upper and lower ranks. From this phenomenon, we could see that the weight was comparatively considered lesser than the other two properties such as texture and hardness. Feeling of dependency which was giving a strong effect to make the both gender of participants to feel positively was provoked by weight property: 'heavy weight helped me to imagine someone is next to me.' However, at the same time participants gave a comment such as 'heavy weight seemed better but when the time gets longer to hold this stimulus, it started to hurt my wrist which brought up a negative feeling.' This phenomenon was highly seen from both genders. Coexistence of positive and negative feeling of the property gave ambiguous thoughts to participants and made them to consider the weight property at the back: 'weight seemed fit to me but later it did not. I do not know whether it is better or not. Anyway, the soft hardness felt very good which is why I ranked this stimulus in this rank.'

6.3 Tactile behavior coping with anxiety

At the theoretical foundation section, types of tactile behaviors were mentioned. During the experiment, how participants playing around with the stimuli was observed by the experimenter. From the both genders of the participants, squeezing and rubbing the stimuli was mostly seen. Since feeling the texture is the very first step to contact with the stimuli, just putting their hand on top of the stimuli was the first behave like observing them. After understanding which stimulus is which, squeezing the stimuli started next. In many cases, rubbing the surface of the stimuli was behaved at the same time with squeezing the stimuli. This case was seen mostly from the stimuli with the smooth level of texture property. However, when the participants did not feel too repulsive from the rough texture after the first step of observing the stimuli, they conducted same steps as squeezing the stimuli with rubbing it at the same time. Shaking, tapping, pushing, padding were also the types of the tactile behavior however they were hardly seen from the participants to act. Lifting was third highest seen behavior from the participants to act but it was usually done to feel the weight of the stimuli. After understanding the weight of the stimuli, lifting was hardly seen however squeezing and rubbing were mostly done to examine the feedbacks of the stimuli. Some participants mentioned that 'I could feel the weight by just holding on it so throwing or lifting did not need to fully feel the weight.' Therefore, when a product is designed for coping the anxiety, designers could consider the most behaviors done to make use of a product such as squeezing and rubbing. Adequate weight can be effective to people to relieve the anxiety however lifting behavior can be considered a little less than the other behavior since the weight can be noticed by just holding on a product.

6.4 Design implication

We now know which property and which combination of properties are preferred to ease the anxiety. In the world, there are numerous numbers of people living and they all have different taste however generally preferred and not preferred properties are found from this research. This research can be provided as a knowledge reference to future designers to design a new product for coping with the anxiety. People feel the anxiety mostly when they need to stand up in front of numbers of people to present or talk something. A ball-pen can be designed with the soft hardness, smooth texture and proper weight therefore a person can hold on to the pen while presenting in front of many people. Also, the preferred property combination can be applied to a pointer to help to ease the anxiety since the presenter mostly hold the pointer on their hand and can take the advantage of the product by using it in a natural act. Other than the pen shape product, cell phone case or more products which are easy to access can be designed by utilizing the findings of this paper (figure 26).

Figure 26. Design implications.

As it was explored at exploratory study, many factors cause the anxiety. We do not know when will the anxiety show up, and we cannot always prepare for the anxiety moment. Because there are too many factors causing the anxiety, we cannot limit the context. However, we know that what is the natural act of people behave during the anxiety moment. When industrial designers try to design a product that can help to cope the anxiety, we cannot limit the specification of a product however this research can help them to find a right direction for their goal. This research will work as a guide for those designers to induce them to design a future product which will have a potential to help new users to reduce or cope when they face a negative emotion such as the anxiety without conducting a forced new behave but do an act of squeezing or touching at the very moment of the anxiety in the natural way.

6.5 Limitations and further study

This research conducted the experiment by combining various variables, properties, such as texture, hardness and weight. Each property has numberless difference of level however only two different levels were set for this research. The purpose of this research was to figure out which property of touch sense is correlate with the negative emotion such as the anxiety. Extreme difference was given to the properties when the stimuli were made thus minimum diversity is given which makes the research not monotonousness and keep the research on the right track from the objective. However, video clip that was made use of to provoke the anxiety during the experiment had a limitation. The clip was worked out to make the anxiety however it is hard to represent that it has a strong effect to make the real anxiety which provokes during our lifetime. The experiment was conducted in stillness status which means that participants were guided to sit on a desk and watch the video clip and his is not exact condition to get the anxiety in daily life. The circumstance of provoking the anxiety made a limitation and this should be researched more to make it clearer and reliable. Also, the background of the participants could be talked as a limitation. Personal taste can be one factor which can change the result of preference however leaning a life background or a background of occupation such as field of design or field of engineering or ages of participants can affect strongly to make the result biased. This research tried to recruit diverse occupation of participants such as design and engineering field participants and administration staffs however the more diversity can deduct more clear and reliable consequences. Considering these limitations, intensified research could be conducted when this foundational research is done and analyzed to make a solid knowledge and meaningful outcome which can provide more options for designers who will run into the ideation step to design a mental related product.

VII. Conclusion

As our society is getting more complex than ever before, the number of people experiencing anxiety in daily life is radically increasing. Even worse, anxiety disorders are the most common mental illness in the US. Under the circumstances, people have used various methods to control and protect their mental from the anxiety. However, few studies have been conducted to identify touch experiences how to help them cope with the anxiety. Therefore, this research was designed to provide a solid foundation knowledge that can be used as a reference for designing mental related products in terms of touch experiences. To achieve the goal of this study, literature study, exploratory study, and experiment stimuli were conducted as a research-through-design process. From the literature studies, we could obtain a knowledge of the importance of the touch interaction such as consciously and unconsciously using hands during the anxiety moment, and therapeutic touch or massage having an effect to relieve the stress and pain. Moreover, the potential use for communicating emotions by the touch sense was studied, and the properties of touch sense for exploring an object was defined. Based on the knowledge found, an exploratory study was carried out to clarify the relationship between touch interaction and the anxiety in our daily life. During the anxiety moment, tendency of using-hand-interaction was highly noticeable. It provided a clear confidence that touch sense of hand is somehow related with managing the anxiety. Experiment stimuli were designed and prototyped base on this finding. Obtained from literature studies, properties mostly tended to be felt from the touch sense were narrowed down to three properties which were texture of surface, hardness of a shell and weight of an object. These properties were combined together, and made eight variables of stimuli. Eight variables of stimuli were tested out while viewing the anxiety provoking video clip at the same time, and we could find the general preference of property to be felt during the anxiety moment. To make the result more clearly and generalizable, quantitative study such as experimenting 50 subjects was conducted. Even though personal taste could bring unexpected results, we could collect a preference tendency of individual property, and combined properties which can be analyzed as a reliable and generalizable data by experimenting large number of subjects. Based on the results from this research, we are willing to suggest a knowledge on the properties of touch sense which is helpful to ease the anxiety. It is believed that designers can make use of this knowledge as a reference to induce them to design future products which will have a potential to help people to reduce or cope with the anxiety in case they might face.

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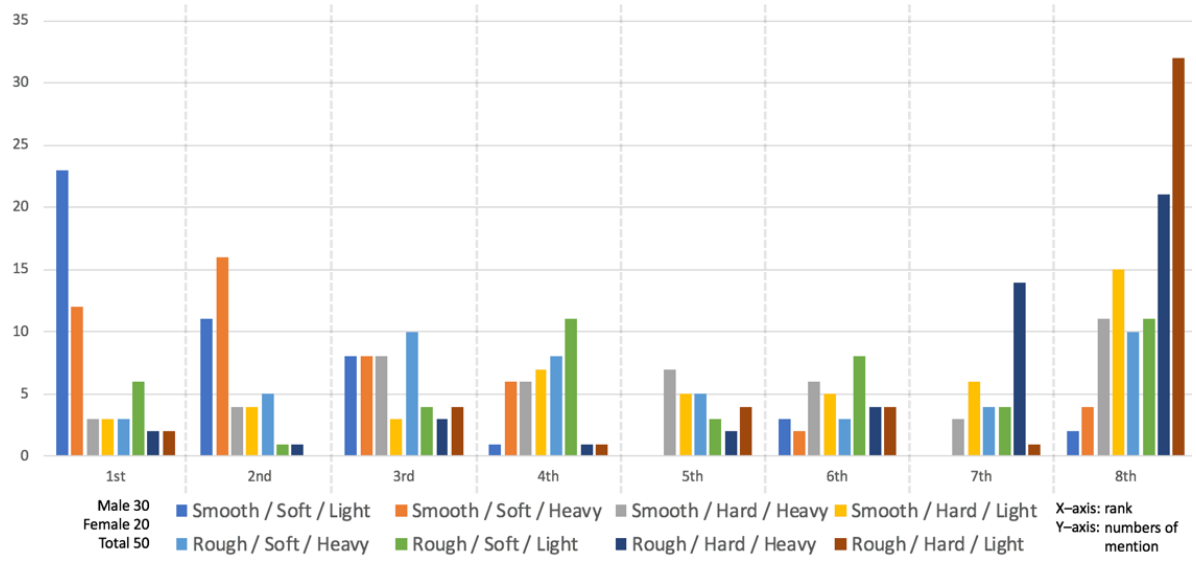
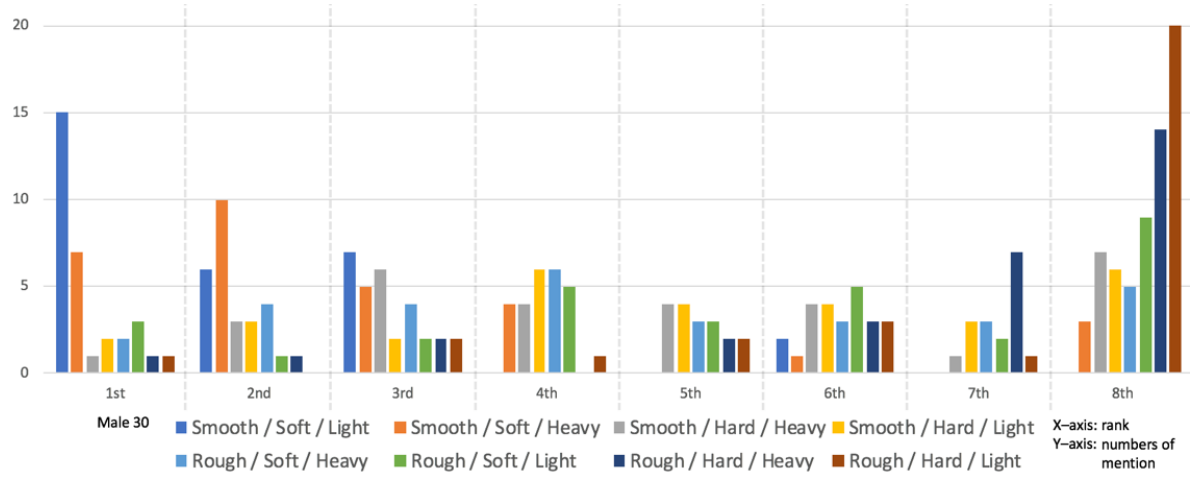
APPENDIX

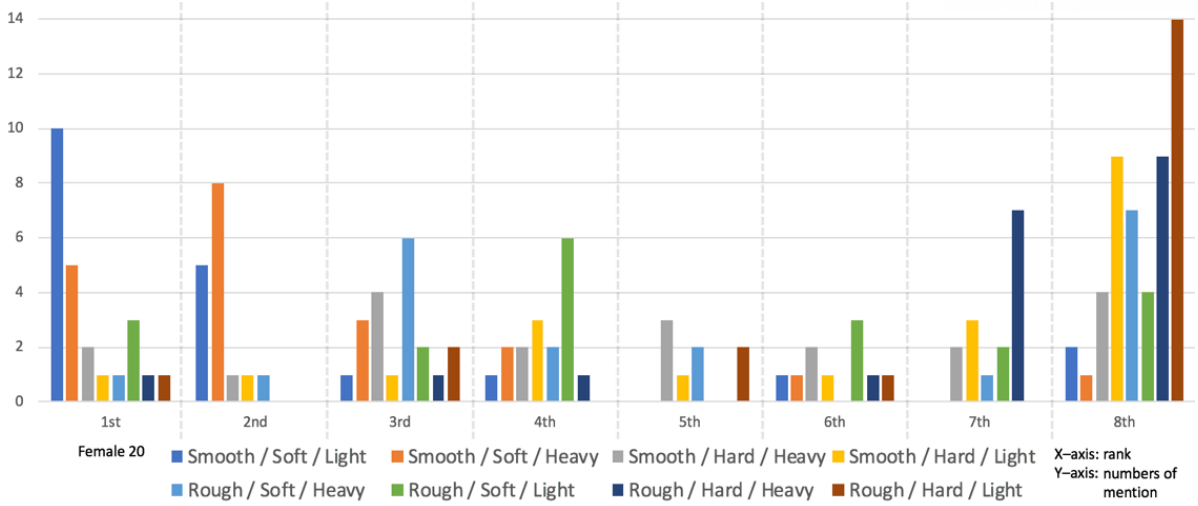
Stimuli preference graph in numbers of mention



Appendix 1. Overall stimuli preference.



Appendix 2. Stimuli preference of Male participants.



Appendix 3. Stimuli preference of Female participants.

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